Description of WO0160280

DEVICE OF DENTAL PHOTOPOLYMERISATION Of APPLICATION.

The invention milked with a device dephotopolymerisation of composite materials, of application in particular in the dental field, comprising a source of light, as well as average optics to direct and emit the luminous energy produced by the aforementioned source in direction of a zone to light. The composite materials used dansl' dentistry are generally at base of a résinephotopolymérisable of which the molecular structure changes under 1' effect of a light radiation a wavelength given according to the capacity for absorption of material used. Thus, in the course of polymerization, this radiation activates lesphotoinitiateurs of material, during a duration calculated according to the energy of this radiation to avoid a too important heating of fabrics surrounding the zone of treatment. It is advisable to observe that the parameters of the radiation, wavelength, intensity, durations, depend of course on the particular composition of each composite, but also of its color and its thickness. A darker composite and of greater mass will require, for saphotopolymerisation a radiation of stronger intensité.C' is than one calls the parameters of polymerization, which, until there, were never programmed with precision. One connaîtd' now and already of the devices dephotopolymerisation answering the description which is made by it above. Thus of such devices comprise a source of light and average optics to direct and emit the luminous energy produced by the aforementioned source in direction of the zone to light (or clinical site). This average optics arises, for example, in the form of optical fibres. In the final analysis, these apparatuses known to date are adapted to emit a radiation of a profile defined without possibility, for the operator, to intervene on this last. In fact, the only parameter on which an action is possible with precision is the time of lighting. Also, such devices hardly have flexibility in use and apply limited.

In the final analysis, these apparatuses known to date are adapted to emit a radiation of a profile defined without possibility, for the operator, to intervene on this last. In fact, the only parameter on which an action is possible with precision is the time of lighting. Also, such devices hardly have flexibility in use and apply limited. As a source of light in this type of apparatus, it is used, for example, of the mercury discharge lamps which present the disadvantage of emitting in the spectrum of the ultraviolet rays, which is dangerous for the eyes and the oral mucous membrane of the patients. Other devices use halogenous lamps which have, they, the disadvantage of having a lumen/watt report/ratio, a weak and high dissipation thermal compared to luminous energy produced, which obliges to limit the rise of the power to obtain greater intensities. In addition, certain devices are equipped with lasers, but the pencils of light that they generate correspond to a monochromatic light which cannot, because of its spectrum wavelengths reduced, to polymerize, there still, which well defined composites. Moreover, the lasers are expensive apparatuses which present, moreover, and high implementation maintenance costs. It is still known devices which call upon electrodes spaced and subjected to potential differences electric ready to produce an electric arc through partially ionized gas at high temperature. Such systems use, in combination, an infra-red filter placed immediately in front of the source and making it possible to obtain a luminous spectrum of emission ranging between 400 and 800nm. A filter passebas makes it possible to then fix the high cut-off frequency of the filter at approximately 515 Nm. However, in these devices, the system of filtering does not make it possible to increase, without danger, the luminous power of the source, because the luminous energy absorptive by biological fabrics can lead to their destruction in the event of strong rise in the temperature. In in

addition to, the energy profile, which represents the variations of the emitted light intensity with the course time, cannot tre modified. That excludes, consequently, any possibility of adapting it to composite materials of various colors, for example. There are also devices àphotopolymériser using energy plasma and having a zone of selective emission isolated thanks to more or less complex filtrations. A document FR-98.01243 describes such an apparatus

It should be noted that such devices have the effect of letting pass from the highly heating radiations in zones beyond the 1200 Nm. This results in to dangerously raise the temperature at the time of polymerization. In addition, these devices require powerful systems of cooling which are of a cost and a high weight. One knows, still, for example by documents EP-A-0880945, JP-A-9010238, US-A-5.634.711, PCT/AU97/00207, of the devices dephotopolymerisation whose source of light is defined by electroluminescent diodes, usually named LED, likely to often emit a radiation wavelengths ranging between 420 and 510 Nm. In fact, ils' acts of a plurality of blue LED laid out on a plate support perpendicularly inside the body of the apparatus. With before this plate of diodes LED, means are to concentrate the emitted radiations and to direct them in direction of a guide of wave whose distal end comes to project this radiation concentrated on surface to treat. This device can borrow the formed' a gun connected to an external electric power supply. In the very particular case of document PCT/AU97/00207, the apparatus still receives means of management of the operation of the source of light, which means of adjustment of the duration are associated. That regulates of anything the problem arising, insofar as iln' is hardly possible to modify, for as much, the energy profile of the emitted radiation, in particular with regard to the intensity of this radiation, its density per unit of area, the number the sequences of irradiation, its or its wavelengths etc.... Finally, the apparatus describes in this document is there still of application limited to a type of determined composite material, the operator having only the possibility of managing, to a lesser extent, the time of lighting to adjust it with the thickness of the material àphotopolymériser. Fact still part of the state of the art according to article 54 (3) CBE, the document EP-0993810 which relates to a device dental dephotopolymerisation of application to which is associated a management and control unit with its allowing operation, by programming, to adjust the power of the source of light and times of illumination to a power defined according to the operational parameters. In particular, it is used as a source of light a halogenous lamp whose pencil of light is guided with the traversd' an optical fibre tube.

In the final analysis, if it is possible, through known techniques to exploit the exposure in a primary way, i.e. to decrease or increase the duration or to act on the luminous power, it is impossible, in real time today, to do it with a great scale of time, power and wavelength. The present invention wants to be with Mrs. to answer the problems noted higher. Thus, the invention relates to a device dephotopolymerisation of composite materials, of application in particular in the dental field, comprising, a source of light, as well as average optics to direct and emit the luminous energy produced by the aforementioned source in direction of a zone to light, characterized by the fact that it comprises: a central processing unit of management of the parameters of operation of the source of light for the definition of an energy profile dephotopolymerisation given; means to adjust the intensity of lighting and the wavelengths of the emitted radiations; as well as means to adjust one or more other parameters of operation of the source of light, namely: - density of illumination per unit of; - and/or numbers it sequences of lighting; - and/or duration of each one of these sequences; so as to adapt the energy profile dephotopolymerisation according to the characteristics of composite material àphotopolymériser.

It was defined by one of the inventors, MonsieurFrançois DURET, a new size, the LUXEL, intended to express the today definite basic unit by three values which are: time, power, and the wavelength. The LUXEL seems a basic unit of emission comparable with the basic unit of the image or PIXEL which is the basic unit of reception. This term thus expresses the LUX in time that intensity and of dimension, the LEL. Advantageously, the source of light consists of electroluminescent diodes LED ready to emit a radiation given wavelength or definite spectrum wavelengths.

According to the invention, the means of adjustment of the parameters of the operation of the source of light consist of means of selection, in a memory connected to the aforementioned central processing unit, of a given energy profile among several profiles preregistered in this memory. According to the invention, the means of adjustment of the parameters of the operation of the source of light consist of means of selection, in a memory connected to the aforementioned central processing unit, of a data, among several preregistered, of one or more adjustable parameters. Advantageously, the memory connected to the aforementioned central processing unit is of the programmable type for the recording of energy profiles dephotopolymerisation and/or data relative to one or more adjustable parameters, suited to tre selected. Preferentially, the device comprises means of seizure, such as a keyboard with keys and/or a touch screen and/or any other means of seizure, in particular remotely, for the recording, in the memory, of energy profiles and/or data corresponding to an adjustable parameter in the memory. Among the means of remote seizure, one will observe that the device dephotopolymerisation can call upon means of remote loading of data, that is to say thanks to a modem integrated or through micro computer, pourtélécharger, for example, new energy profiles through network of the type Internet or Intranet. Obviously, such a solution makes it possible to consider other functionalities, such as leteleciagnostic or the remote maintenance of the device dephotopolymerisation in conformity with the invention. Of Mrs., through this intercommunication with an Internet site, the user can tre systematically informed of the last evolutions of its apparatus. Of Mrs., it can tre held informed, in real time, conditions of the placement of composite material that it souhaitephotopolymériser or evolution of the reaction in progress. By way of example still, when the Intenet site to which the user is connected, at a given moment, is that of a supplier of a composite material, they can exchange all kinds of information. In particular, the user can, then, directly place an order to his supplier for the composite material of which it notes an out-of-stock condition. Of Mrs., the supplier can, in his turn, to pass from the advertisements to his customer, messages which can come to be posted, is on a screen of the device if this one is equipped with it, that is to say on the screen of the PC by the intermediary of which it is connected to Internet network, or directly by projection of the message through average optics and source of light of this device dephotopolymerisation as that at summer made visible in figure 14. The advantages which rise from this invention consist of what the device applies quasi universal, because its utilisationn' is not simply limited to a type of given composite material. Insofar as it is possible to adopt any energy profile dephotopolymerisation, this apparatus is, indeed, able to adapt to the characteristics of each one of these materials. The opérateum' is thus more constrained with the use of a particular composite material range, without counting that it can modify to him Mrs. the conditions operating of its device dephotopolymerisation by taking into account its own experiment, but also conditions of placement of material. Finally a good adjustment of the LUXELS makes it possible to meet the needs expressed in this field. Other goals and advantages of this invention will appear in the description which will follow, being referred to a mode of

realization, given by way of indicative and nonrestrictive example. The comprehension of this description will be facilitated within sight of the drawings attached and in which: - figure 1 is a schematized representation of the device object of this invention, its body appearing in transparency; - figure 2 is a schematized representation of wafers supports of directed diodes LED perpendicularly with the axis longitudinal of the body of the device and distributed around this axis; - figure 3 is a schematized representation and crosses from there according to III-III of figure 2; - figure 4 represents, in a schematized way, the device and an electric support of adapted loading; - figure 5 represents, in a schematized way, the device with means of connection to a power supply of the sector type; - figure 6 corresponds to a schematized representation of the device of which the part, defining the source of light and average optics to direct and emit luminous energy, is envisaged interchangeable; - figure 7 and one similar sight on figure 5, the guide of waves, partly before device, being him-Mrs. conceived of retractable type to allow its replacement; - figure 8 illustrates, in a schematized way, the device, object of the invention, equipped with means of remote seizure, the reader type of codes bars for the recording of energy profiles and/or other data in its memory; - figure 9 illustrates a mode of realization of the memory of the device under formed' a likely smart card of tre committed in suitable means of reading; - figure 10 is a simplified synoptic representation of the electronic diagram of the device; - figure 11 is a more detailed synoptic representation electronic diagram of the device; - figure 12 represents, graphically and with titred' example, the power of food of several modules of LED for an energy profile dephotopolymerisation during a given sequence; - figure 13 is a chart illustrating, the intensity or the density of illumination according to time, the wavelength and the power of emission or the number of diodesémettantes. - figure 14 is a schematized representation illustrating of the means of seizure of the external type to the device for the programming and the data record and others in its memory, these means of seizure comprising, amongst other things, of the means of remote loading, for example on an Internet site; - figure 15 is a similar representation with the preceding figure illustrating the device equipped with average optics able to project readable information on an unspecified support, in particular for a communication in return since an Internet site for example; - figure 16 is a schematized representation of the distal end of the laid down guide of waves ready to emit, on the one hand, a spot of light of aiming and, on the other hand, a luminous contour of lighting determining the zone to treat, holding account that the wavelength of the emitted radiation can be in the ultraviolet ones; - figure 17 is a schematized and preferential representation of the distribution of diodes of lighting and aiming, without effect of polymerization, on a wafer support of diodes LED perpendicularly extending to the axis from the body from the device. - figure 18 is a schematized representation of a guide of waves carried out according to a first preferential mode of realization; - figure 19 is a similar representation with the preceding figure illustrating a guide of waves according to another mode of realization.

As represented in figure 1 of the drawing attached, the present invention relates to a device dephotopolymerisation of composite materials which will particularly find a intérêt in the dental field. This device 1 comprises a body 2 inside whose an opinion its principal components give. Thus, this device 1 comprises a source of light 3, preferentially in the form of diodes electroluminescent, known as LED, able to emit a light radiation a given wavelength or definite spectrum wavelengths. By way of example represented on this figure 1, these diodes LED can tre distributed on a wafer support 4 perpendicularly extending to the longitudinal axis 5 from body 2 from device 1. It should be noted that the number of these diodes LED is a function of the power

of the light radiation to emit. Also, to avoid, for devices of raised power and irradiation, to increase, in a significant way, the section of body 2, these LED can tre distributed on several wafers supports 4A, 4B, 4C, 4D which, as represented in figures 2 and 3, are, in this case, parallel to directed the longitudinal axis 5 of body 2, while being distributed around this axis 5. Device 1 comprises, still, of average optics 6 to direct and emit the luminous energy produced by source 3 in directiond' a zone of lighting corresponding to the zone of composite material àphotopolymériser. Like visible on this figure 1, such average optics 6 can tre consisted optical fibres 7 whose proximale end arrives on each diode LED 8 and whose distal end coincides with the distal end 9 of a guide of waves 10 being partly before body 2. It will be observed particularly that inventionn' presents it is by no means limited to such average optics in the form of optical fibres. Indeed, they can still borrow the shape of one or more lenses, even celled' a bar known as of ROD, known by the specialist of the profession familiarized in the field of the guides of waves, and, which in the present application, has the advantage of supporting the mixing of the emitted radiations reducing to a few percent the energy fall due to this average optics. Insofar as one of the characteristics of this invention consists in optimizing the reaction dephotopolymerisation, this reduction of the energy fall of the light output has all its importance. Moreover, this average optics 6 can be presented in the form of a bar at bits, whose each bit corresponds to a LED which allows a projection of the light of each LED in a selective way on support. The device is transformed thus into means of projection of image. Like that plushaut in connection with figure 15 was exposed right now, this characteristic makes it possible to the user to project on a suitable support of elementary information coming from an Internet site, for example, to even dialogue with this site. In addition, as represented in figure 6, the source of light 3 and average the optics 6 can tre integrated in an interchangeable part 11 of body 2, thanks to means of connection adapted, which facilitates its replacement in the event of ageing of the source of light 3, without counting that celleci can tre substituted by a more or less powerful source of light, for example comprising diodes LED more or less. Moreover, the interchangeableness of the source of light makes it possible to replace this one quickly to modify the emission spectrum while using, for example, a source containing radiant LED in different wavelengths. Thus, one can, with titred' example, to set up diodes emitting in the infra-red to activate thermohardening reagents or of bleaching. To note, still, that the guide of waves 10, containing average optics 6, can, with him only or in combination with the solution mentioned above, tre interchangeable. In this connection and according to a preferential mode of realization of this guide of waves 10, in addition represented in figure 18, it consists of two kinds different of fibres optique10A et10B, whose first defines the proximale10' part of this guide of waves 10, while the second kind of optical fibres constitutes the distale10 part of it ' '. Thus, the part proximale 10' is carried out by an optical fibre comprising a homogeneous heart out of optical glass with high index of refraction etd' an envelope of glass with index of lower refraction. The purpose of it is to mix and make homogeneous the image resulting from the source of light to diodes LED. Moreover it proves much cheaper in comparison with a device of the anamorphosor type. As for the part distale10 ", it consists of optically insulated and in parallel welded fibres sets. The purpose of they are conduction of luminous flow until the site to light. The connection between the proximale10' part and the distal part 10' ' is obtained by the intermediary of a ring of maintien10C. In this connection and according to the mode of realization, more particularly visible figure 19, the two kinds of optical fibres 10A and 10B are jointly coupled inside this ring of maintenance 10C in order to optimize the optical coupling and to avoid carrying out two parts

of guide which the user must fix one in the other. That makes it possible to avoid in particular polluting optical surfaces in contact of these optical fibres, that is to say during a handling or at the time of sterilization. It is necessary to observe, still, that this manner of designing the guide of waves 10 using two kinds of optical fibres makes it possible to at will bend it on the level of its distal end and consequently to give him the most suitable form. Device 1 still comprises a central processing unit 12 of management of the operation of the source of light 3 for the definition of an energy profile dephotopolymerisation given. Thus, thanks to a power supply 13, in autonomous form, therefore of one or more batteries 14, preferentially refillable standard, and/or means of connection 15 (visible in figure 5) with the sector of electric power supply of a dwelling, this central processing unit 12 order the operation of the source of light 3 according to given sequences' of lighting and with definite powers. In figure 4, it at summer represented a support of loading 14A more particularly adapted to receive device 1 during the recharging of the batteries 14 integrated in this last. As for diodes LED 8, they, preferentially, are subdivided in elementary modules 16, represented schematically in figures 10 and 11, comprising, each one, a number of diodes identical or not and supplied with regulating circuits 17. Those allow, through the central processing unit 12, to feed diodes LED of each one of these elementary modules 16 with well defined powers. Like, more particularly, visible on these figures 10 and 11, these regulating circuits 17 of the elementary modules 16 are controlled through registers of shift 18 which the central processing unit comprises 12 and allowing, still, to feed diodes LED of the aforesaid modules 16 according to different sequences' of lighting. In order to optimize the integration of these elements in a portable unit, therefore compact, the whole of the registers of shift 18 and regulating circuits of current 17 can tre gathered in a ASIC 19. To note, moreover, that the intért of this design of registers of shift and regulating circuits for each module 16 of diodes LED 8, resides in the fact that ellen' is not limited in term of maximum luminosity, since several of these modules of diodes 16 will be able tre put in cascade. To still answer this preoccupation with an integration, on the opposite face of wafers 4; 4A, 4B, 4C, 4D, compared to diodes LED 8 or modules 16 of diodes, can tre montél' ASIC 19. It was represented of figure 11 a more detailed synoptic diagram of the device. Thus, this one receives a power pack BC, suivid' a block of filtering BF, then of a food D.C. current cd. before a logical chart CPU where microphone-controller MC is found, like at least a connection series LS for a connection to a PC, for example, for the remote loading, even with a chart of library of program. Microphone-controller MC is still connected to a memory flash MF and a user interface provided IU, in particular of a keyboard with keys and means of posting. Lastly, through chart of piloting CP of diodes LED one comes to attack the various elementary modules 16 comprising, each one, in an example of realization 64 diodes LED suited to tre ordered per packages of 8 at various levels of current. On this diagram also appears the means of reading of codes bars 25. As represented in figures 15 and 16, the device receives, also, of the means of lighting 30 quin' have any effect of polymerization, but which make it possible to delimit and return the zone to be treated 32 more visible. By way of example, these means of lighting peuventtre independent of the source of light 3. However, when the latter is presented in the form of diodes LED, some of them peuventtre designed to emit a radiation which does not affect the reaction of polymerization of composite materials. In a preferential mode of realization of the invention, these means of lighting 30 are conceived ready to emit a luminous contour of lighting 31 (like visible in figure 15) or diffuse around the zone to treat 32. It should be noted that the emitted radiation can be, with regard to its wavelength, in the beach of the ultraviolet rays. Moreover, they comprise, advantageously, a spot of light of aiming

33 intended to define the operative field. In figure 17, it, more particularly, is represented directed wafer support 4 of diodes 8 a perpendicularly with the axis of body 2 of device 1. This wafer 4 comprises, preferentially, in periphery, the diodes 8A for the emission of beam of the diffuse or annular lighting 31, while in the center is assembled the diode 8C of aiming. In figure 12, it is represented, in a graphic way, the power of food of each module 16 of diodes 8 for a given energy profile, during a definite sequence of radiation. While, in figure 13, it was represented the intensity or the density of illumination according to the time wavelength and power of emission or emitting number of diode. This representation makes it possible, still, to highlight that by using various modules 16 of diodes 8 as a source of light, it is possible to modulate the spectrum wavelengths of the emitted radiation. Il is appropriate to recall, at this stage, that each type of composite material comprises its own energy profile dephotopolymerisation. Thus the DSC, Differential pourPhotocalorimetry with Sweeping, or DPC, in English, are methods making it possible to know at which time the illumination of a composite material is effective so that it polymerizes. Of Mrs., the studies of stress and contraction, even of rise in temperature and modification of the mechanical properties make it possible to know the ideal profile which the curve of the LUXELS must represent while trying to reduce the bad results as much as possible, like the rise in the stress by supporting the best results like the rates of polymerization. It is thus necessary to be able to adapt this profile to each one of these materials. Also, according to the invention, device 1 comprises, in combination, of means 20 to adjust the intensity of illumination and the wavelengths of the emitted light radiations, like one or several of the following parameters of the operation of the source of light 3, namely: - density of illumination per unit of; - and/or numbers it sequences of lighting; - and/or duration of each one of these sequences; so as to adapt the energy profile of polymerization according to the characteristics of composite material àphotopolymériser. These means 20 consist, according to the invention, in means of selection, in a memory connected to the aforementioned unit centrale12, of a given energy profile among several profiles preregistered in this memory and/or of a data, there still, among several having been recorded beforehand in the aforementioned memory, relative to one or more of the adjustable parameters. Thus, by way of example, in a predetermined menu, the operator has the possibility of selecting only the parameter of the energy profile on which it wishes to intervene, such as the duration of the sequences of lighting and/or the power of food of the sources of light and/or the wavelength or the spectrum wavelengths of the emitted radiation. Then, for this selected parameter, it will be able to retain, among several solutions which are proposed to him, that which seems to him to be appropriate. This operator still can, to have the choice, through this menu, between various preestablished energy profiles. It should be noted that these means of selection 21 can tre integrated into device 1 in the form of a key or of a combination of keys 22 etd' a screen 23 and/or still in the form of a touch screen, just like they can tre external with this device and to borrow the shape of a micro computer to which comes to be connected this last, either materially, or via remote means of communication, of the infra-red type, with other or frequency modulation. Such a solution, more particularly, was represented in figure 13. Obviously, a combination of these various types of means of selection is possible. Advantageously, the device comprises, also, of the means of seizure, there still in the form of a keyboard with keys 22 and/or of a touch screen and/or any other means of seizure, in particular remotely, for the programming of the memory connected to the central processing unit 12, precisely to record there various energy profiles and/or various data relating to the adjustable parameters. It should be noted that these means of seizure can

appeal, as represented in figure 13, with means of remote loading of data 24, in particular with the traversd' a micro computer, pourtélécharger, for example, new energy profiles through network of the type Internet These means of remote loading can still borrow the shape of a modem, either directly integrated into the device, or with the support of loading 14A to which it was refers higher in description. According to another mode of realization, these means of seizure are presented in the form of means of reading of codes bars 25, solution represented schematically in the figure8. Thus, these means of reading of codes bars 25, can tre substantially definite by the guide of waves 10, or to be partly back body 2, as that is visible on this figure8. One can also plan to associate these means of reading of codes bars 25 the support of loading 14A, just like they can borrow an independent form, for example that of a pencil suited to tre connected, materially or remote, in particular by infra-red or radio, according to case's with device 1 or from his support of loading 14A. In figure 9, it is represented a memory in the form of a smart card 26, preferentially of the programmable type, device 1 comprising a reader 27 suitable. There also, this card reader to chip 27 can find himself on the level of the support of loading 14A, in particular if one wishes to reduce 1' tool that come to handle 1' user. Once again, it will be observed that device 1 can comprise a combination of these various modes of realization of the means of seizure described above. The purpose of means 20 to adjust one or more parameters of the operation of the source of light are in particular to still intervene on the density of illumination per unit of area, like that was indicated above. In fact, it is possible to regulate this density of illumination while intervening, in particular by the intermediary of the regulating circuits 17, on the number of diodes LED fed on the level of each elementary module 16 and/or on the intensity of their food during a reaction dephotopolymerisation. This adjustment can intervene, also, through guide of waves 10 envisaged ready to modify the focusing of the source of light in a dynamic way making it possible to send the maximum of luminous energy, either on the surface, or in-depth of material to be polymerized. According to, another likely solution of tre applied with one and/or the other of the described solutions cidessus, this adjustment of the density of illumination per unit of area can result from the replacement of the guide of waves 10 envisaged interchangeable, individually and/or with the source of light 3. It arises from the description which precedes that the present invention answers, perfectly, with the problem arising in the sense that it brings a real response to the lack of adaptability of the current devices for laphotopolymerisation of various types of composite materials. In fine account, the device, in conformity with the invention, gives the possibility to the user of adjusting the operating conditions of its apparatus as it wishes it, so that iln' is limited more, like often in the past, with the use of a category of composite materials given.